BS

by Cyrus Bhandari

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Submission ID: 2091975606
File name: BinSense.pdf (621.74K)
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- Complete the sketch:

```
#include <ESP32Servo.h>
#include <Ultrasonic.h>
#include <FirebaseESP32.h>
#include <WiFi.h>
#include <WiFiMulti.h>

// define pins for sensors and actuators
#define trigPin1 33  // trig pin for ultrasonic sensor 1
#define echoPin1 25  // echo pin for ultrasonic sensor 1
#define trigPin2 32  // trig pin for ultrasonic sensor 2
#define echoPin2 35  // echo pin for ultrasonic sensor 2
#define irSensorPin 34  // pin for IR sensor
#define servoPin 14  // pin for motor
#define greenLedPin 26  // pin for green LED
#define redLedPin 27  // pin for red LED

// define distance threshold for determining if the dustbin is empty
#define emptyDistance 9

// create objects for sensors and actuators
Ultrasonic ultrasonic1(trigPin1, echoPin1);
Ultrasonic ultrasonic2(trigPin2, echoPin2);
Servo servo;
WiFiMulti wifiMulti;

// Firebase configuration
#define FIREBASE_HOST "https://binsense-aff88-default-rtdb.asia-southeast1.firebasedatabase.app/"
#define FIREBASE_SECRET "ifGQgLH93oHevezAFBVZxnGjQbSCcbpr95eujPxA"
FirebaseData firebaseData;

void setup() {
  Serial.begin(115200);
  servo.attach(servoPin);
  pinMode(irSensorPin, INPUT);
  pinMode(greenLedPin, OUTPUT);
  pinMode(redLedPin, OUTPUT);

  digitalWrite(greenLedPin, LOW);
  digitalWrite(redLedPin, LOW);
```

```
wifiMulti.addAP("KIIT-WIFI-NET.", "20051203@kiit");
wifiMulti.addAP("Cyrus's iPhone", "enterprise");
wifiMulti.addAP("Xiaomi 12 Pro", "12345678");

// WiFi setup
if (wifiMulti.run() == WL_CONNECTED) {
  Serial.println("Connected to Wi-Fi");
  // Your code here
} else {
  Serial.println("Failed to connect to Wi-Fi");
}
delay(1000);

// Initialize Firebase
  Firebase.begin(FIREBASE_HOST, FIREBASE_SECRET);
while (!Firebase.ready()) {
  delay(1000);
  Serial.println("Connecting to Firebase...");
}
```



```
 Serial.println("Firebase connected");
}

void loop() {

 // read the IR sensor value
 int irSensorValue = digitalRead(irSensorPin);

 // if someone is detected by the IR sensor
 if (irSensorValue == LOW) {
  digitalWrite(greenLedPin, HIGH);
  digitalWrite(redLedPin, LOW);
  Serial.println("Person detected");
  // check if the dustbin is empty
  float distance1 = ultrasonic1.read();
  float distance2 = ultrasonic2.read();
  int status = 1;

  Serial.print("Distance 1: ");
  Serial.print(distance1);
  Serial.print(", Distance 2: ");
  Serial.println(distance2);
```

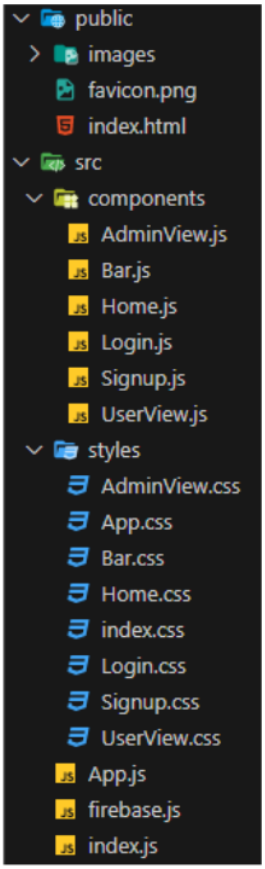
```
  if (distance1 < emptyDistance && distance2 < emptyDistance) {
    Serial.println("Dustbin is not empty");
    digitalWrite(greenLedPin, LOW);
    digitalWrite(redLedPin, HIGH);
    servo.write(0);  // close the bin
    status = 0;
    delay(2000);
  } else {
    Serial.println("Dustbin is empty");
    servo.write(180);  // open the bin
    while (digitalRead(irSensorPin) == LOW) {
      // keep the bin open as long as someone is detected by the IR sensor
      delay(100);
    }
    servo.write(0);  // close the bin
    digitalWrite(greenLedPin, LOW);
    digitalWrite(redLedPin, LOW);
  }

  // update the bin status in Firebase
  Firebase.setInt(firebaseData, "/bins/1/status", status);
  if (firebaseData.dataAvailable()) {
    Serial.println(firebaseData.payload());
  } else {
   BinSense
Serial.println(firebaseData.errorReason());
  }

 } else {
  // if no one is detected by the IR sensor, turn off the LEDs and keep the bin closed
  digitalWrite(greenLedPin, LOW);
  digitalWrite(redLedPin, LOW);
  servo.write(0);
 }
}
```

Website:

- Install NodeJS and Visual Studio Code
- Create a new directory that will store the React App.
- Install the following dependencies to the directory using npm: npx-create-react-app react-router-dom react-sripts react
- The work tree looks like this:



- The approach for building the components:
  The **App.js** component sets up the routes for different pages of the application using react-router-dom. It also handles the authentication state of the user using Firebase's onAuthStateChanged function. If the user is authenticated, they are redirected to the appropriate view (UserView or AdminView), and if not, they are redirected to the login page.

  The **Home.js** component renders the homepage of your application, displaying information about the smart dustbin management system. It includes sections with images, titles, descriptions, and buttons for signing up or logging in.

  The **Signup.js** component provides a form for users to create an account. It uses Firebase's createUserWithEmailAndPassword function to handle user registration.

  The **Login.js** component renders a login form for users to authenticate. It uses Firebase's signInWithEmailAndPassword function to handle user login.

The **AdminView.js** component is intended for the admin user and displays a table of bins and users. It fetches the data from Firebase's Firestore and Realtime Database and allows the admin to delete bins or remove subscriptions for users.

The **UserView.js** component is for regular users and displays a table of bins and their statuses. It fetches the data from Firebase's Realtime Database and allows the user to remove bins. In order to add a bin a unique binID and secret have to passed. Firebase validates this and returns the required data.

The components are ensured to work in cohesion with each other. The states and props are properly transferred between them.

The Firebase utilities used in the app provides server-side and database logic to the application. We will look at Firabase in the next section.

- The UI was also made with similar consideration of each component individually as well as the system as a whole for cohesion.

Backend:

- The development process for the backend of our website using Firebase, Firestore, Realtime Database, and Authentication involves the following steps:

- Firebase project setup: We start by creating a new Firebase project and configuring it according to our requirements. This involves creating a project in the Firebase console, enabling the necessary services, and obtaining the configuration details required to connect our backend to Firebase.

- Firestore setup: We set up Firestore, which serves as our NoSQL document database. We define the structure of our collections and documents to store user data. For example, we might have a "users" collection where each document represents a user and contains fields like admin, id, and subscriptions.

- Realtime Database setup: We configure the Realtime Database to handle real-time updates of the dustbin state. We define the necessary database structure to store and update the bin states as they change. The Realtime Database is updated via an ESP32 microcontroller, which sends updates to Firebase whenever there is a change in the dustbin state.

- Authentication setup: We enable the Firebase Authentication service and choose the email-password sign-in method for user authentication. This allows users to register and log in to our website using their email and password credentials. Firebase Authentication takes care of securely storing and managing user credentials, session management, and user authentication workflows.

- User management with Firestore: We utilize Firestore to store user data such as the user's admin status, unique ID, and bin subscriptions. The subscriptions field holds the IDs of the bins that the current user is subscribed to and can monitor. This allows us to associate user-specific data with their Firestore document and manage user subscriptions effectively.

- ESP32 integration with Realtime Database: We set up the ESP32 microcontroller to send updates to the Realtime Database whenever there is a change in the dustbin state. This involves integrating the Firebase Realtime Database SDK into the ESP32 firmware and establishing a secure connection with Firebase. The ESP32 updates the relevant bin state in the Realtime Database, and these changes are reflected on the website wherever the relevant bins are displayed.

- Security rules and data validation: We configure security rules for Firestore and Realtime Database to define access permissions and data validation rules. These rules ensure that only authenticated users can access and modify their own data and enforce data integrity and validation constraints. We define rules to prevent unauthorized access to sensitive information and maintain data consistency.

- Error handling and logging: We implement error handling mechanisms to gracefully handle exceptions and unexpected scenarios. We log relevant information to assist with debugging and troubleshooting. Firebase provides logging and error reporting features that help capture and analyze errors and exceptions occurring in the backend.

- Throughout the development process, it's important for us to document our backend code, configurations, and any important decisions made. This documentation will aid in future maintenance, collaboration, and troubleshooting.

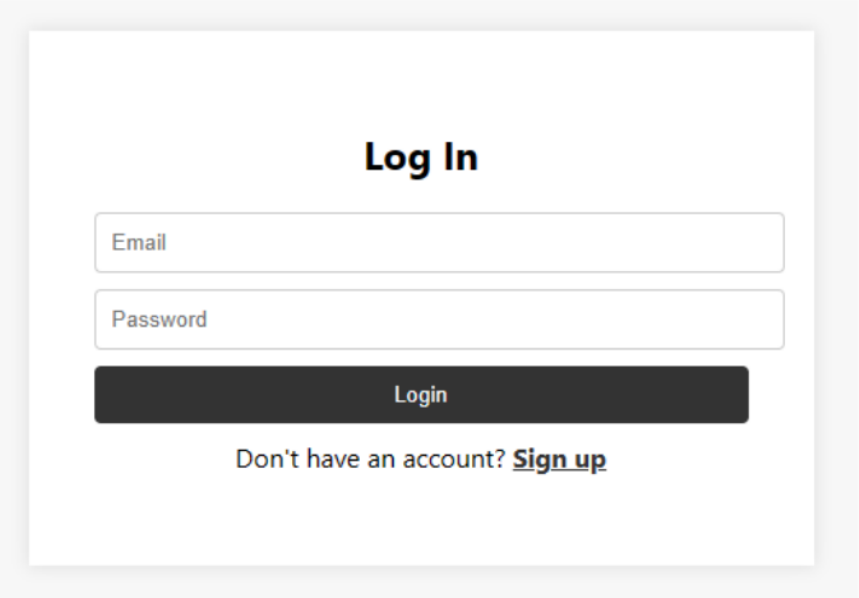
4.2 Testing OR Verification Plan

Test ID	Test Case Title	Test Condition	System Behavior	Expected Result
T01	Admin Access	An admin logs in to the website. If the credentials are accurate, the admin should be directly routed to the admin dashboard.	/adminview route opens	/adminview route opens
T02	User Access	A user logs in to the website. If the credentials are accurate, the admin should be directly routed to the user dashboard.	/userview route opens	/userview route opens
T03	User Signup	User data added to Firestore	Firestore updates and user can login	Firestore updates and user can login

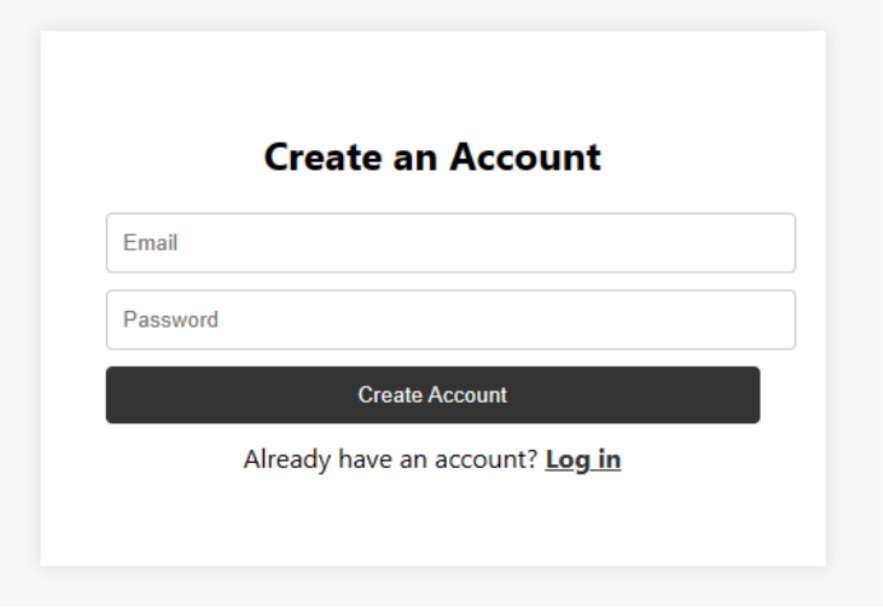
Test ID	Test Case Title	Test Condition	System Behavior	Expected Result
T04	Bin Status Update	When the ultrasonic sensors detect that the bin is filled, the ESP32 communicates this with the Realtime database.	Bin status updates to '0' from '1'. The dashboard updates from '1'to 'Offline'.	Bin status updates to '0' from '1'. The dashboard updates from '1'to 'Offline'.
T05	Admin actions: Deleting bins and user subscriptions	From the admin dashboard, one of the added bins is removed. The subscriptions of a user are also removed.	The table entry of the bin is removed, the data is removed from the Realtime database, the user subscriptions are updated to be empty in Firestore.	The table entry of the bin is removed, the data is removed from the Realtime database, the user subscriptions are updated to be empty in Firestore.
T06	User actions: Bin added with credentials and then removed	A user adds 'Bin 1' by passing the binid and secret. The bin is added to the table view. Firestore updates the user subscriptions. User then removes the bin.	Firestore and user dashboard changes are seen immediately.	Firestore and user dashboard changes are seen immediately.
T07	User attempts to add bin with invalid credentials	A user logs in and attempts to add a bin using an incorrect secret.	Error logged and shows alert "Invalid bin ID or secret"	Error logged and shows alert "Invalid bin ID or secret"

4.3 Result Analysis OR Screenshots

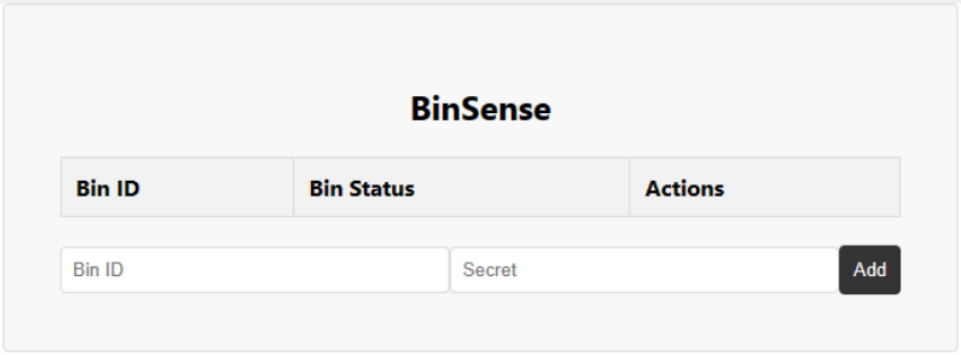
Login page:



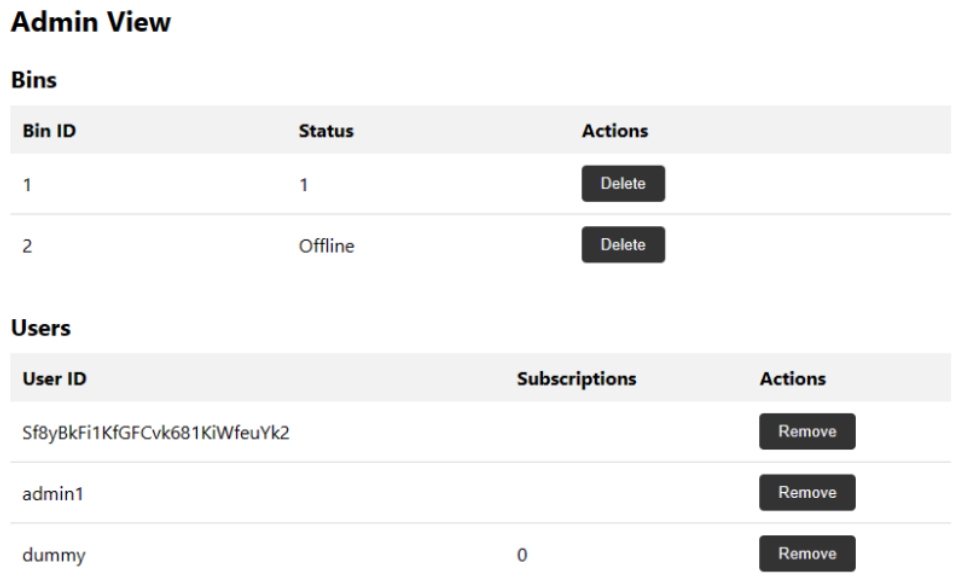
Signup page:



Userview:



Adminview:



4.4 Quality Assurance

The quality of the project is assured by our respected minor project mentor Mr. Debashis Hati.

Chapter 5

Standards Adopted

5.1 Design Standards

In our project, we emphasize the importance of following sound design practices to ensure a well-structured and maintainable system. Wee prioritize the following recommended practices:

- Employing clear and consistent naming conventions for variables, functions, and classes to enhance code readability and maintainability.
- Breaking down complex tasks into smaller, manageable functions or modules to promote code reusability and ease of maintenance.
- Utilizing appropriate code documentation to facilitate understanding and collaboration among team members.
- Considering principles of software design, such as modularity, encapsulation, and separation of concerns, to enhance system flexibility and scalability.

5.2 Coding Standards

To maintain code quality and readability, we follow a set of coding standards and best practices. We emphasize the following guidelines:

- Writing concise and readable code by using appropriate indentation and formatting.
- Using meaningful and descriptive names for variables, functions, and classes.
- Keeping functions and methods focused on a single task or responsibility for improved code maintainability.

- Encouraging the use of comments to provide additional context and explanations when necessary.

- Applying consistent coding styles and conventions across the project to enhance code readability and collaboration.

5.3 Testing Standards

We recognize the importance of testing and quality assurance in our project. We prioritize the following practices:

- Conducting thorough testing at various levels, including unit testing, integration testing, and system testing, to ensure proper functionality and detect defects.

- Creating well-designed test cases that cover different scenarios and edge cases to maximize test coverage.

- Utilizing appropriate testing tools and frameworks to automate testing processes and increase efficiency.

- Regularly reviewing and refining our testing approach based on feedback and lessons learned from previous testing cycles.

- Documenting and reporting any discovered defects or issues to facilitate their resolution.

Chapter 6

Conclusion and Future Scope

6.1 CONCLUSION

The automatic waste management system using ESP32 has been experimentally proven to work satisfactorily. The webapp for the BinSense system is also demonstrated to work correctly. We could see the live status updates, functional databse queries, and autrhentication.

Smart dustbins are the now the needs of Smart buildings. Smart waste monitoring and management is the keen idea of smart city planners. This implementation of smart garbage Bin indicator receptacle, gives a solution for unsanitary environmental condition in a city. This implementation of Smart Garbage collection bin using internet, Ultrasonic sensor, Servo motor and ESP32. This system assures to send status on dashboard of dustbins when the garbage level reaches its maximum. The record can be sent to the higher authoritybwho can take appropriate action. Therefore, the smart garbage management system makes the garbage collection more efficient. The use of solar panels in such systems may reduce the energy consumption.

6.2 FUTURE SCOPE

Using this system as framework, the system can be expanded to include various other options which could include mobile application control of motor and wi-fi controlledmonitoring. These will expand the working capability and efficiency of this prototype.

The main aim of this project is to reduce human resources and efforts along with the enhancement of a smart city vision. We have often seen garbage spilling over from dustbins on to streets and this was an issue that required immediate attention. The proverb “Cleanliness is next to god and clean city is next to heaven” inspired us to conceptualized the project. Smart dustbin helps us to reduce the pollution. Many times, garbage dustbin is overflow and many animals like dog or rat enters inside or near the dustbin. This project can avoid such situations. And the message can be sent directly to the cleaning vehicle instead of the contractor’s office. Swatch Bharat Abhiyan (English: Clean India Mission and abbreviated as SBA or SBM for "Swatch Bharat Mission") is a national campaign by the Government of India, covering 4,041 statutory cities and towns, to clean the streets, roads and infrastructure of the country.

In our system, the Smart dustbins are connected to the internet to get the real time information of the smart dustbins. In the recent years, there was a rapid growth in population which leads to more waste disposal. So, a proper waste management system is necessary.

References

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SAMPLE INDIVIDUAL CONTRIBUTION REPORT:

BinSense

name
roll

Abstract: The aim of our project is to develop an Automated Waste Management System that utilizes IoT technology to efficiently manage solid waste. The objective is to provide a system that can monitor and manage waste in real-time, reducing manual labor and promoting environmental sustainability.

Individual contribution and findings: Hardware Setup and Integration Introduction
BinSense is a smart waste management system that aims to automate the process of waste collection and disposal. It utilizes embedded systems and sensors to enable dustbins to open and close their lids automatically when they detect a person in front of them. The system also integrates with the cloud, allowing waste management authorities to monitor and analyze the data collected by the sensors in real-time.

Individual Contribution

As a member of the team responsible for hardware setup and integration, my main contribution to the project was designing and implementing the embedded systems that enable the dustbins to operate automatically. This involved selecting and integrating the necessary components such as sensors, microcontrollers, and motors. I was also responsible for integrating the dustbins' sensors with the cloud, ensuring that data could be stored and monitored via a web application.

Challenges Faced:

During the hardware setup and integration phase, several challenges were encountered. One of the primary challenges was the voltage requirements of the components, which were different from what the microcontroller could provide. This necessitated the use of an external battery setup. To link the components to the battery, a breadboard was used as a common circuit. Initially, a voltage regulator was used, but it failed to support the system. This required us to re-evaluate the design and find alternative solutions.
Another significant challenge we encountered was with the motor that controlled the opening and closing of the dustbin lids. Despite receiving power and signal, the motor was not working correctly. After several rounds of troubleshooting, we discovered that the negative terminals of the motor, microcontroller, and battery setup had to be synced together on the breadboard. This allowed the motor to function correctly and the dustbin lids to operate automatically.

Solutions Developed:

To overcome the challenges faced during the hardware setup and integration phase, we developed several solutions. For the voltage requirements challenge, we decided to use an external battery setup that could provide the necessary power to the components.

The voltage regulator was salso replaced with a more reliable and efficient one. Additionally, I redesigned the circuit to optimize power consumption and prevent overloading. For the motor issue, we conducted extensive testing to identify the root cause of the problem. After syncing the negative terminals of the motor, microcontroller, and battery setup on the breadboard, we were able to get the motor to work correctly. We also implemented several safety features to prevent damage to the motor or other components. Conclusion In conclusion, I am proud of the contribution I made to the hardware setup and integration of BinSense. Despite encountering several challenges, we were able to develop solutions that enabled the dustbins to operate automatically and transmit data to the cloud securely. Through collaboration with other team members, we were able to create a smart waste management system that has the potential to revolutionize the way waste is collected and managed in urban areas.

Individual contribution to project report preparation: Student should mention his/her role in preparing the group project report indicating which chapter and portions contributed.

Individual contribution for project presentation and demonstration: Student should mention his/her role in preparing presentations and part of the project demonstrated.

Full Signature of Supervisor:
…….

Full signature of the student:
……..

SAMPLE INDIVIDUAL CONTRIBUTION REPORT:

BinSense

name
roll

Abstract: The aim of our project is to develop an Automated Waste Management System that utilizes IoT technology to efficiently manage solid waste. The objective is to provide a system that can monitor and manage waste in real-time, reducing manual labor and promoting environmental sustainability.

Individual contribution and findings: Arduino Setup and Integration

As a member of the team responsible for the Arduino setup and integration, my main contribution to the project was ensuring the seamless integration of the Arduino with the other components of the system. This involved setting up the Arduino microcontroller board, configuring the sensors, and developing the necessary code to interact with the cloud-based database.

One of the major challenges we faced during the Arduino setup was configuring the sensors to detect the presence of waste accurately. We spent a considerable amount of time calibrating the sensors and ensuring that they were sensitive enough to detect the presence of even small amounts of waste. We also had to ensure that the sensor readings were reliable and consistent to avoid false alarms or missed detections.

Once we were satisfied with the sensor readings, we proceeded to integrate the Arduino with the other components of the system. To achieve this, we had to develop the necessary code to enable the Arduino to communicate with the cloud-based database. This involved setting up the Wi-Fi connection and configuring the Firebase SDK.

One of the challenges we faced during the setup of the Arduino was setting up the Wi-Fi connection. We had to ensure that the Arduino was able to connect to the Wi-Fi network securely and reliably, as any disruptions in the connection could lead to missed sensor readings or delayed data transmission. We also had to ensure that the Wi-Fi credentials were secure and protected against potential attacks.

After setting up the Wi-Fi connection, we proceeded to configure the Firebase SDK. This involved creating a Firebase account and setting up a Realtime Database to store the sensor readings. We also had to configure the Firebase Authentication feature to ensure that only authorized users could access the system. Once the SDK was set up, we had to develop the necessary code to interact with the database and ensure that the data from the sensors was being accurately sent to the database in real-time.

One of the major challenges we faced during the integration process was ensuring that the Arduino and the website were communicating with each other seamlessly. We had to ensure that the website was able to fetch and display the real-time data sent by the Arduino accurately. We also had to make sure that the website was able to send commands to the Arduino to trigger actions such as opening and closing the dustbin lid.

To achieve this, we had to develop a communication protocol that allowed the website and the Arduino to exchange data and commands in real-time. We used the Firebase Realtime Database as the intermediary for this communication, with the website reading from and writing to the database and the Arduino reading from and writing to the database as well.

One of the major advantages of using the Firebase Realtime Database was its ability to handle real-time data updates. This meant that the website could display the sensor readings and the dustbin status in real-time, providing users with up-to-date information on the status of the system.

Overall, my experience working on the Arduino setup and integration was extremely rewarding. While there were some challenges along the way, I was able to apply my knowledge of embedded systems and programming to develop a solution that integrated seamlessly with the other components of the system. By working collaboratively with the other members of the team, we were able to overcome the challenges we faced and deliver a product that met the requirements of the project.

It is important to note that while the data collected by the Arduino was sent via the Firebase SDK, it was not sent to cloud servers for any kind of analytics. Our focus was on developing a system that was efficient in collecting data and communicating with other components of the system in real-time. With the successful integration of the Arduino into the BinSense system, we were able to create a reliable and efficient system for waste management.

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Individual contribution for project presentation and demonstration: Student should mention his/her role in preparing presentations and part of the project demonstrated.

Full Signature of Supervisor: Full signature of the student:

……. ……..

SAMPLE INDIVIDUAL CONTRIBUTION REPORT:

BinSense

name
roll

Abstract: The aim of our project is to develop an Automated Waste Management System that utilizes IoT technology to efficiently manage solid waste. The objective is to provide a system that can monitor and manage waste in real-time, reducing manual labor and promoting environmental sustainability.

Individual contribution and findings: Frontend Development

As a member of the frontend development team for the BinSense project, my primary responsibility was to design and develop the user interface of the system. Our team was tasked with creating a website that would allow users to interact with the system and access its various features. To achieve this, we developed several components, including the homepage, signup page, login page, navbar, user dashboard, and admin dashboard. Each of these components had a specific purpose and was designed to be intuitive and easy to use for both individual users and administrators. The homepage was designed to provide a brief overview of the BinSense system and its main features. It featured a clean and modern design with a hero image, prominent call-to-action buttons, and a concise explanation of how the system works. The signup and login pages were created to allow users to create an account or log in to an existing account. We made sure that these pages were user-friendly and provided clear instructions for users to follow. The navbar was designed to provide easy navigation throughout the website. It featured links to the homepage, user dashboard, and admin dashboard. Additionally, we included a search bar that allowed users to quickly search for specific dustbins or locations. The user dashboard was designed to provide individual users with a summary of their account activity and information about the dustbins they were managing. Users could view their account details, track their waste generation, and view their past transactions. We also included a feature that allowed users to request a pickup of their waste. The admin dashboard was designed to provide administrators with an overview of the system's activity. Admins could view all the dustbins on the map, manage user accounts, view transaction history, and generate reports. This dashboard was designed to be comprehensive and provide admins with all the information they needed to effectively manage the system. One of the biggest challenges we faced during the development process was ensuring that the website was responsive and accessible across different devices and screen sizes. To achieve this, we implemented a responsive design approach that allowed the website to adapt to different screen sizes and orientations. We made sure that the website was optimized for desktop, tablet, and mobile devices. Another challenge was ensuring that the website was secure and protected against potential attacks. To achieve this, we integrated Firebase Authentication into the website, which allowed us to securely manage user authentication and access control. We also implemented several security features, such as form validation and input sanitization, to prevent potential attacks.

We worked closely with the backend development team to ensure that the frontend was properly integrated with the backend. This involved testing the website with various use cases and ensuring that it was able to effectively communicate with the backend API. We made sure that the website was performing optimally and that there were no issues with the communication between the frontend and backend. Overall, I am proud of the work our team has done on the frontend of the BinSense system. We have created a user-friendly and intuitive website that effectively communicates with the backend API and provides users with the features they need to effectively manage their waste. Our website is responsive, secure, and accessible across different devices and screen sizes. I am confident that our team has created a website that will have a positive impact on the environment and help reduce waste.

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BinSense

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Individual contribution and findings: Backend Development and Firebase Integration

As a backend developer on the BinSense project, I was responsible for designing and developing the server-side of the application. The backend of the system was built using Firebase, which is a platform that provides a suite of services for building web and mobile applications. Firebase provides a complete backend solution, including authentication, cloud storage, and real-time databases, which made it an ideal choice for our project.

One of my first tasks was to configure Firebase for our project. This involved setting up the Firebase account, creating a new project, and configuring the Realtime database and Firestore. Time was spent configuring both the Realtime database as well as Firestore, which are used for storing user data and dustbin information. We chose to use Firestore for storing user data because it offers more advanced querying and scalability features.

Since the scale of the system wasn't massive, I ensured that the implementation offered high scalability by following best practices and keeping the design modular. To accomplish this, I created a serverless architecture, which means that the backend services do not run on a server, but rather are triggered by an event. This architecture is highly scalable and cost-efficient since it only incurs charges when an event occurs.

Additionally, I implemented the logic for authentication, role-based classification, document, and table queries. Firebase provides easy-to-use APIs for all these functionalities, which made the development process smoother. While APIs were not exactly used in the system, I added and configured the Firebase SDK to the React app (website), allowing the website to communicate with the backend services seamlessly.

The primary purpose of the backend development was to handle the authentication, role-based classification, and document and table queries. As such, the backend was developed using Firebase services. The Firebase SDK was added and configured to the React app (website), allowing for seamless communication between the website and the backend services.

Although the scale of the system wasn't massive, the implementation offered high scalability by following best practices and keeping the design modular. The use of Firebase's services allowed for the efficient and straightforward development of the backend, which resulted in a robust and scalable system.

In conclusion, my contribution to the BinSense project's backend development and Firebase integration was crucial in enabling the system to function as intended. The use of Firebase's services allowed for the efficient and straightforward development of the backend, which resulted in a robust and scalable system.

The implementation of a serverless architecture further ensured that the system was highly scalable and cost-efficient. The configuration of both the Realtime database and Firestore allowed for the storage of user data and dustbin information, respectively. The addition and configuration of the Firebase SDK to the React app allowed for seamless communication between the website and the backend services.

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